

METHOD AND INSTRUMENT FOR THERMAL SUTURE CUTTING

Priority Information

This application claims the benefit of U. S. Provisional Application Serial No. 60/391,887, filed June 27, 2002, the content of which is incorporated by reference herein in its entirety.

Technical Field Of The Invention

The present invention relates to the field of suture removal. More particularly, the present invention provides a method and instrument for thermally cutting a suture which minimizes the tension placed on the suture during removal, thereby reducing pain, bleeding and tissue disruption.

Background Of The Invention

Suture removal is an important part of wound repair in medicine. Internal sutures are absorbable so they are essentially "removed" by the body. External sutures or sutures on the surface of the body are nonabsorbable. Nonabsorbable sutures are advantageous, because they have a higher tensile strength than absorbable sutures. As such, they are the preferred suture for closure of external wounds. However, they carry with them the additional task of requiring manual suture removal.

The removal of sutures is problematic for many doctors. Current suture removal techniques utilize standard instruments to manipulate and cut a stitch. This technique requires considerable tension on, and manipulation of, the stitch. The resulting pain, bleeding, and tissue disruption are uncomfortable and anxiety provoking for the patient and compromise the cosmesis of the wound repair. Lastly, the technique is time consuming for the physician.

Current manual suture removal techniques rely on two methods. The first technique utilizes a suture removal kit containing a pair of forceps, scissors, and gauze pad. This technique consists of grasping the knot of the suture with the forceps and lifting the stitch enough to slip the scissors under the suture. The scissors then cut the

stitch, which is then pulled out of the skin with the forceps. Unfortunately, the scissors generally have a blunt end, making it difficult to raise the stitch sufficiently off the skin to slip the distal tip of the scissors under the stitch. Additionally, the action of bringing the scissors blades together to cut the stitch creates significant tension on the suture. The gauze, included in the suture removal kit, is most aptly used to wipe away the blood which results from the manipulation necessary to remove the suture. The second current method for suture removal replaces the scissors with a thin knife but requires the same manipulation and results in similar tissue disruption and bleeding.

It is accordingly an object of this invention to provide a method and instrument for suture removal which produces less tension in the suture than current methods.

It is accordingly a further object of this invention to provide a method and instrument for suture removal which minimizes pain, bleeding and tissue disruption.

It is a further object of this invention to provide a method and instrument for suture removal which allows sutures to be removed in less time than currently available methods and devices.

Summary Of The Invention

The present invention provides a method and instrument for applying heat to the loop portion of a suture used to close a wound so as to melt the suture material, causing the loop to rupture. The cutting method disclosed and associated instrument allow the suture to be separated while producing less tension in the suture than current methods, thereby minimizing patient discomfort, tissue disruption and bleeding.

In a preferred method of the instant invention, a resistive heating element is brought into contact with the loop of a suture used to close a wound. The heating element is placed under the suture loop (or stitch), preferably between the patient's skin and a knotted portion of the suture. Power is supplied to the heating element for a brief time, during which the element heats and melts the suture in contact therewith, causing the loop to rupture. Thereafter the suture is removed in the usual manner, i.e., using forceps or the like to extract the remaining suture material.

Accordingly, the present invention provides a suture removal instrument comprising:

- (a) an elongated body having a proximal handle portion and insulated distal portion;
- (b) a first conductive member extending from the insulated distal portion of the elongated body, terminating in a tapered tip;
- (c) a resistive heating element extending alongside the first conductive member and affixed at its distal end to the tapered tip;
- (d) conduction means for supplying power to the heating element; and
- (e) activation means for controlling the supply of power to the heating element.

The elongated body may serve as a handle for the operator to grasp and/or as a housing for the operating components, such as the power source, conduction means and activation means. The elongated body may be formed from any suitable medical-grade material, such as plastic, metal, polycarbonate, polyvinyl chloride, and the like. In a preferred embodiment, the elongated body comprises a cylindrical housing.

The conductive member is shaped to facilitate insertion thereof into a suture loop. The tapered tip allows it to gently slide under the loop of the suture, between the patient's skin and a knotted portion of said suture. For example, the tapered tip may comprise a conical point. Alternatively, the tip may take the form of flat shovel or spade-shaped scoop.

The resistive heating element is preferably a thin filament, formed from a material such as nichrome, tungsten, nickel, stainless steel or the like. The heating element preferably joins the tapered tip of the conductive member to form an acute angle with the axis of said tapered tip ranging ranges from about 5 to about 40 degrees.

The power source required to heat the resistive heating element may be carried by the suture removal instrument itself. For example, in a preferred embodiment, the power source comprises one or more batteries contained within the elongated body. Alternatively, the elongated body may be fitted with a standard power cord and connector adapted for use with a conventional wall outlet.

The conduction means for supplying power (typically electrical power) to the heating element may take any suitable form. Examples of suitable conduction means include, but are not limited to, wires, conductive structural components, electrodeposited metal coatings and the like.

The activation means for controlling the supply of power to the heating element may take any suitable form. Examples of a suitable activation means include, but are not limited to, an actuator button, an on/off switch, and a foot pedal.

The suture removal instrument optionally includes a second conductive member placed between the insulated portion of the elongated body and the resistive heating element. The second conductive member preferably extends from the insulated distal portion of the elongated body and is disposed next to the first conductive member in a parallel fashion. In operation, one of the conductive members is connected to one side of the power source (e.g., a battery) and the other is connected to the opposite side of the power source so as to form a complete current path. The activation means can be placed anywhere along the current path. The conductive members do not heat up because they have a much larger cross-sectional area than the resistive heating element.

In a particularly preferred embodiment, the suture removal instrument comprises an elongated body having a proximal handle portion and an insulated distal portion. The handle portion contains a power source and an activation button. An insulated portion protrudes from the distal end of the proximal handle portion. First and second conductive members protrude distally from the insulated portion. It is conceivable that the heating filament could be integral with the conductive members, or that a single conductive member could be used, with the proximal end of the heating filament being connected directly to conduction means contained within the insulated portion of the elongated body.

In a preferred embodiment, the first conductive member is longer than the second conductive member and has a tapered distal end. Both the conductive members are preferably formed from an easily machined metallic material, such as brass or stainless steel, and should have good thermal conduction properties. Both the members have a co-planar axis with each other and with the proximal handle portion. The distal end of the second element is affixed to the tapered distal end of the first elongated member by a thin

resistive heating element. The thin resistive heating element forms an acute angle of about 5 to 40 degrees with the axis of the first elongated member. The first and second conductive members are connected to the power source and the activation button by a suitable conduction means discussed above. Because the conductive members have much larger cross-sections than the thin resistive heating element, the conductive members are not heated by the current. Because the element is energized for only a short period of time, heating of the conductive members by the filament is minimal.

In another embodiment, intended for cutting very heavy sutures, a thermal shield, formed from a suitable plastic, ceramic or other insulating material, surrounds at least a portion of the tapered distal tip which is slipped into the suture loop, so as to prevent contact between the heated elements and the patient. Cutting very heavy suture may require that the resistive heating element be energized for longer periods of time or heated to higher temperatures and slight heating of the first and second conductive members may occur.

These and other objects and features of the invention will become more fully apparent when the following detailed description is read in conjunction with the accompanying figures and examples.

Brief Description Of The Drawings

Figure 1 is a perspective view of a thermal suture cutting device constructed in accordance with the principles of this invention.

Figure 2 is an expanded view of the distal portion of the object of Figure 1.

Figure 3 is an expanded side elevation view of the distal portion of the device of Figure 1.

Figure 4 is a perspective view of the device of Figure 1 during use.

Figure 5 is a perspective view of an alternate embodiment of the thermal suture cutting device, including a thermal shield.

Figure 6 is an expanded view of the distal region of the device of Figure 5, with the thermal shield removed.

Figure 7 is an expanded side elevation view of the device of Figure 6.

Figure 8 is a perspective view of the thermal shield of the device of Figure 5.

Figure 9 is an expanded perspective view of the distal region of the device of Figure 5.

Figure 10 is an expanded side elevation view of the distal region of the device of Figure 5.

Figure 11 is a perspective view of the device of Figure 5 during use.

Detailed Description Of The Preferred Embodiments

In the context of the present invention, the following definitions apply:

The term “suture” is used to refer both to the fine thread or other material used surgically to close a wound or join tissues and to the stitch so formed.

The term “distal” refers to that end or portion which is situated farthest from the hand of the operator and closest to the body of the patient when the device is in use.

The term “proximal” refers to that end or portion situated closest to the hand of the operator and farthest away from the body of the patient when the device is in use.

The accompanying figures, described in detail below, illustrate aspects of the invention but are in no way intended to limit the scope of the present invention.

Referring to Figures 1 through 3, thermal suture remover 1 has an elongated cylindrical body portion 2 having a proximal end 3 and a distal end 4, the elongated sections forming a handle and containing therein at least one battery. Insulator piece 5, made from a suitable plastic or ceramic dielectric material, protrudes from distal end 4 and has a distal-most surface 6, from which protrudes a first elongated rigid conductive piece 7 and a second elongated rigid conductive piece 8, pieces 7 and 8 being separated by distance 9. Elongated piece 7, protruding distance 10, has a tapered distal region 11. Elongated piece 8, protruding distance 12, has a distal end 13. Proximal end 16 of heating element 15, is affixed to distal end 13 of elongated piece 8, and distal end 17 of heating element 15 is affixed to the top surface 18 of tapered distal region 11 of elongated piece 7 such that the axes of pieces 7, 8 and 15 are coplanar. Heating element 15 is inclined to axis 20 angle 21 determined by the difference between distances 10 and 12, and distance 9. Depressing button 22 connects conductive pieces 7 and 8 to the at least one battery by a suitable conduction means, such wires, conductive structural components, electrodeposited metal coatings or the like.

As seen in Figure 4, showing a wound **31** in tissue **32** closed by stitch **30**, when removing a stitch, tapered distal portion **11** of conductive piece **7** is inserted into the loop formed by suture **30**, and advanced until suture **30** contacts distal end **17** of heating filament **15**. Insertion of the conductive piece may be aided by grasping the knot of the stitch with forceps and lifting slightly. Power is supplied to heating filament **15** for a brief period so as to heat filament **15**. The portion of suture **30** in contact with heated filament **15** then melts and ruptures. Thereafter, the suture is removed from the skin in the usual manner. Because heating filament **15** is energized for only a brief time, and because conductive pieces **7** and **8** have a relatively larger thermal mass and cross-sectional area as compared to heating filament **15**, conductive pieces **7** and **8** do not heat sufficiently to cause patient discomfort.

In another embodiment used, for instance, for cutting very heavy suture which may require that the filament be heated for a longer time, a plastic or ceramic shield protects the patient from possible heating of the conductive piece. Referring to Figures 5 through 8, thermal suture remover **51** has an elongated cylindrical portion **52** having a proximal end **53** and a distal end **54**, the elongated sections forming a handle and containing therein at least one battery. Protruding from distal end **54**, insulator piece **55** having a cylindrical distal portion **73** of radius **74** and key **75** of width **76**, and made from a suitable plastic or ceramic dielectric material, has a distal-most surface **56** from which protrude a first elongated rigid conductive piece **57** and a second elongated rigid conductive piece **58**, pieces **57** and **58** being separated by distance **59**. Elongated piece **57**, protruding distance **60**, has a tapered distal portion **61**. Elongated conductive piece **58** protruding distance **62**, has a distal end **63**. Proximal end **66** of heating element **65** is affixed to distal end **63** of elongated conductive piece **58**, and distal end **67** of heating element **65** is affixed to distal surface **68** of elongated conductive piece **57** such that the axes of pieces **57**, **58** and **65** are coplanar. Heating element **65** is inclined to axis **70** angle **71**, determined by the difference between distances **60** and **62**, and distance **59**. Depressing button **72** connects conductive pieces **57** and **58** to the at least one battery by a suitable conduction means. Thermal shield **78**, made of either a suitable thermoplastic or ceramic material, surrounds elongated piece **57** and distal end **67** of heating filament **65** and mounts to insulator **55**.

Referring primarily to Figure 8, but also Figure 6, shield **78** has a tubular section **79** and a U-shaped channel portion **80** having a closed, tapered, distal end **81**. Tubular section **79** has an inner diameter **90**, approximately equal to twice radius **74** (see Figure 6) of cylindrical portion **73** of insulator **55**, and an axial slot **85** of width **82** slightly greater than width **76** of key **75**. The inner width **83** of channel portion **80** is slightly greater than the diameter of elongated piece **57**, and length **84** of channel portion **80** is slightly greater than length **60** of piece **57**. Shield **78** is preferably made from a suitable polymeric or ceramic material.

Referring to Figures 9 and 10, shield **78** is assembled to insulator **55**, the tubular portion **79** of shield **78** being affixed to cylindrical portion **73** of insulator **55** and alignment being established by key **75** of insulator **55** and slot **85** of shield **78**. Channel portion **80** of shield **78** surrounds elongated piece **57** such that distal end **67** of filament **65** is recessed within the channel.

Referring to Figure 11, showing a wound **91** in tissue **92** closed by suture **90**, when removing a stitch, tapered distal portion **81** of shield **80** is inserted into the loop formed by suture **90**, and advanced until suture **90** contacts distal end **67** of filament **65**. Insertion of the shield **80** may be aided by grasping the knot of the stitch with forceps and lifting slightly. Power is supplied to filament **65** for a brief period so as to heat filament **65** and the portion of suture **90** in contact with filament **65** causing suture **90** to melt and rupture. Thereafter the suture is pulled from the skin in the usual manner. Shield **80** prevents heat from elongated piece **57** from reaching the patient.

The disclosure of each publication, patent or patent application mentioned in this specification is specifically incorporated by reference herein in its entirety.

The invention has been illustrated by reference to specific examples and preferred embodiments. However, it should be understood that the invention is intended not to be limited by the foregoing description, but to be defined by the appended claims and their equivalents.